The Need to Document and Preserve Natural Soundscape Recordings as Acoustic Memories

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Abstract

Soundscapes and other monitoring recordings register the acoustical activities in a locality portraying its acoustic dimension, depicting human and animal presence. Soundscapes recordings in natural areas, including urban sites, can be used to describe biodiversity, by documenting their presence, and characterize the environment. These recordings are thus primary sources of information, and securing its conservation may guarantee the acoustic memory of habitats and ecosystems. These recordings have a potential application in future recreational, educational or research activities. Soundscape recordings, and it associated information, if organized in a long-term data-curation framework, such as sound archives or collections can ensure its preservation and maintain its value. Overall, after acknowledging the need to preserve soundscapes recordings, a road map must be developed to identify past important non-preserved recordings and to promote the inclusion of a long-term preservation strategy for recordings in starting projects.

Keywords: Acoustic recordings, sonic environment, bioacoustics, nature, Sound archives and collections

1. Introduction

1.1. Soundscapes and biodiversity

Sound is an essential component of biodiversity and we just need to listen to the great amount of different sounds present all around us to observe that fact. But animals are not the only source of sound, the acoustics of landscapes (soundscapes) are constituted from sounds of animals (biophony; e.g. birds, insects) but also by the elements (geophony; e.g. wind, water), and also humans (antrophony; e.g. stationary machines, planes, cars) (Pijanowski et al., 2011). These sounds occupy a significant portion of the frequency spectrum, from the low frequency elephants or human related sound pollution, to ultrasonic bat sounds (Fletcher 2004). Animal sounds (biophony) are an important component of the acoustical environment and are present in most localities, from very urbanized, to arid habitats, underwater or pristine terrestrial environments (Boebel et al. 2008; Obrist et al. 2010; Pijanowski et al. 2011). Within these environments a great variety of species, such as insects, fishes, anurans, reptiles, birds and mammals use sounds in activities such as mate attraction, territorial defense, food request or prey detection.

Due to the importance of sound in a species' biology, is not surprising that sound embodies an important fraction of biodiversity, that may convey important information on the other dimensions of diversity such as species, functional or evolutionary diversity (Obrist et al. 2010; Sueur et al. 2008; Gasc et al. 2013). In fact, since many species use sound in a daily basis, sound gives indirect cues of overall biodiversity, being very useful in conservation and biodiversity programs (Dawson and Efford 2009; Blumstein et al. 2011).

1.2. Soundscapeshold biodiversity information

The information about organisms, their activities, and the environment in general captured in soundscapes can be useful in understanding patterns and tendencies of biodiversity as well as individual species behavior or evolution (Sueur et al. 2008; Luther and Baptista 2010). Bioacoustics and especially soundscapes may play an important role in monitoring and assessing the effect of climate change, invasive species, or other factors related to crises related to biodiversity (Rands et al. 2010). The advantage of using soundscapes is that it is not taxonomically oriented, or at least may be recorded with enough bandwidth to register sound from elephants to bats, allowing their use in an entire community based approach.

Soundscape recordings document the acoustic dimension of reality, comprising a documental testimony of local biodiversity (Schafer 1971; Krause 2008). Many animal sounds

encodes species-specific information that can be used to confirm the presence of specific species (Aubin 2004) and sound is often used as a valuable taxonomic tool to assess new species (Biju et al. 2011). Beyond the species specific code, each species may possess a wide range of messages each with specific ethological contexts (de Araújo, Marcondes-Machado, and Vielliard 2011) allowing to assess the behavioral context of an individual within a soundscape recording.

The presence of a set of species in soundscape recordings has the observational value of placing each species in a specific location at a determined time. This information can be used for species distribution studies, to identify changes in community composition, such as the presence of new exotic species or registering changes in a species' range. Depending on the recording protocol, soundscape recordings may also be useful in determining a relative measure of species richness at a site and even as an index of abundance for some species. Additional information about the species' habits such as the breeding period or timing of migration may also be extracted from these recordings. The consistent capture of long-term soundscape recordings can also provide information which can be used to assess population tendencies, and may be especially valuable for species of conservation efforts (Gilbert, McGregor, and Tyler 1994). Soundscapes can also be used in other areas such as behavior and evolution, for studying the relationships between noise and vocal activity of animals, geographic variation of species calls or song evolution.

Soundscapes are also excellent vehicles for disseminating and promoting scientific knowledge encouraging people to discover the natural world. Recordings may used in exhibitions to promote interaction between visitors and the natural world by illustrating different ecosystems, or natural cycles, endangered or extinct species. Pleasant, enjoyable, natural soundscape recordings also have esthetic value and listening to them may have a positive impact on a person's quality of life.

1.3. Acoustic memory of habitats and ecosystems

Soundscape recordings can preserve an acoustic memory of habitats and ecosystems. An acoustic memory is a preserved recording, or set of recordings, captured with associated data and information representing the acoustics of a place at a specific time. It is the result of a soundscape recording that registers the acoustical activity at a sensitive radius and it produces a valuable primary source of information about the species present, the acoustical environment, and the humanization of a place (see above). Time series of soundscapes may reveal the dynamics of urbanization in terms of community composition, that can be revisited to re-examine previous results and to collect new information about habitats and

ecosystems. Soundscape recordings hold information that may allow access to information related to past events, inform the listener about present events and provide information to predict future trends and the outcome of present events.

2. Collections of natural soundscapes and monitoring recordings

2.1. Collections of natural soundscapes

Soundscape recordings organized as collections with a long-term data-curation framework ensure the preservation of a soundscape and maintain their value as acoustic memories. Biological collections are subsets of the diversity of the natural world which have been developed as part of an intellectual process of sampling, preservation and ordering (Lane 2011) accessible to the outside user community either for research or public outreach (Alberch 1993; Lane 1996). Collections provide a major source of historical information, with a broad taxonomic and geographic span (Boakes et al. 2010; Lips 2011) that allow one to contrast historical information with present-day studies in a way that might otherwise be impossible (e.g. biological invasions). Collections are composed not only of preserved specimens but are combined with biogeographical, ecological, and biographical (Lane, 1996). Thus, the long-term preservation commitment, specimen documentation, scope and availability to the public for study, establishes a data curation framework to development of soundscapes collections within the concept of acoustic memory of habitats and ecosystems.

2.2. Soundscapes as scientific specimens

Animal sound recordings along within soundscape recordings pose interesting challenges to the traditional concept of specimens and broaden the concept. Traditionally biological specimens are preserved objects, characterized taxonomically, spatially and temporally in a manner which registers the presence of a species at a specific place and time (Hawks 1999). These can consist of parts of individuals (e.g. tissue collections), whole individuals (e.g. skin collections), fossils (e.g. paleontological collections) or even extended phenotypes (e.g. nest collections). Sounds are ephemeral and their recorded existence depends on a support medium (e.g. tapes, hard drives or flash memories). Soundscapes are also not taxonomically

oriented but are primary sources of information that model the real world and can be re-examined to test new hypotheses.

Specimen documentation (such as metadata) is fundamental in maintaining the scientific value of a specimen (Lane, 1996). Specimens are always documented with information that describes it the taxonomically, characterizing its location and date of collection among other information. In the case of soundscape recordings additional information is needed about the recording process; including information such as microphone (brand, model), recorder (brand, model), microphone filtering, sample rate, bit depth, information about editing, author of the recording and/or managing the project, recording protocol, recording duration or sound quality (Ranft 2004; Kettle and Vielliard 1991).

However, it should be noted that the capacity to preserve soundscape recordings is not infinite and it is limited by hardware capacity (e.g. storage space) and human resources. In this case soundscape recordists and archivists should select from within the initial pool of recordings a subset that best suits the soundscapes collection objectives in terms of habitat, temporal and geographical coverage in addition to rarity, historical value or recording quality.

The acoustic memory approach is currently being used in the Portuguese Natural Soundscapes Project, which aims to create a contemporary portrait of Portuguese Natural Soundscapes. The project has sampled over 20 sites with a 24 h continuous cycle of recordings using a 5 microphone array. Recordings that are being catalogued and stored to preserve its value as acoustic memory of the sites, currently with circa 1.6 TB, 1350 recordings that represent more then 2800 hours of recordings.

3. The dynamic nature of soundscapes

Soundscapes are changing all around reflecting a world in constant modification. Natural communities composition will naturally change over time, but modifications in soundscapes are especially true in cities, where mankind intensively modifies the environment to establish infrastructure such as roads, buildings, or artificial light. Such modifications in the soundscape will not only promote changes on the species composition of an area (McClure

et al. 2013), but it will also introduce sounds from a panoply of evolving machinery from cars to factories. In this sense soundscapes recorded periodically may depict the dynamics of urbanization, showing how biophony is loss in detriment of an increased antrophony, and also as a testimonial of the presence of a specific species, community composition, or even specific machinery over time and space.

4. A road map towards soundscape recordings preservation

Creating a good acoustic memory based on soundscape recordings will require a great effort preserving existing recordings while preforming new recordings.

The action towards the preservation of existing important soundscape recordings includes an identification phase, which should encompass determining its ownership and preservation status (preserved or not preserved) followed by assessing recoverability, importance and loss risk prior to a preservation plan to guarantee their conservation trough proper storage.

Within the acoustic memory context preforming new recordings to guarantee the spatial and temporal representations of sound is challenging. The preservation process of these recordings are extremely difficult in terms of storage capacity especially if we consider the needed redundancy, that will bring further difficulties. Collaborative work may reduce the difficulties, as it would reduce the weight over a single institution. In order to maximize the quality of such recordings, there is the urgent need to establish standards for the recordings' metadata, as the more additional data there is, the more valuable the recording is. Finally, due to the cost of making and keeping soundscape recordings, we must outline regional objectives, leading a series of recordings over time, which should be made in distinct localities.

5. Concluding remarks

Soundscape recordings retain valuable characteristics which clearly go beyond the value of observational data and carry information that can be best used if organized within a framework similar to an NHC framework. Soundscape recordings should be seen as part of a region's scientific and cultural heritage holding information that may allow for a better understanding not only of biological processes but also of society, and the development of the *urbis*. The establishment of soundscape collections would preserve the acoustic memory and at the same time allow for the confirmation of previous studies results through verification. Soundscapes may be used to test new hypotheses derived from technological and conceptual advances, which may have not been envisioned at the time of collection.

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